

Health Consultation

Indoor Air Quality Evaluation
Philip Services Corporation
(a/k/a Burlington Environmental Incorporated Georgetown Facility)
Seattle, King County, Washington
EPA Facility ID: WAD 000812909

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Prepared by

The Washington State Department of Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry



Foreword

The Washington State Department of Health (DOH) has prepared this health consultation in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the U.S. Department of Health and Human Services and is the principal federal public health agency responsible for health issues related to hazardous waste. This health consultation was prepared in accordance with methodologies and guidelines developed by ATSDR.

The purpose of a health consultation is to identify and prevent harmful human health effects resulting from exposure to hazardous substances in the environment. Health consultations focus on specific health issues so that DOH can respond quickly to requests from concerned residents or agencies for health information on hazardous substances. DOH evaluates sampling data collected from a hazardous waste site, determines whether exposures have occurred or could occur, reports any potential harmful effects, and recommends actions to protect public health.

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Glossary

Agency for Toxic Substances and Disease Registry (ATSDR)	The principal federal public health agency involved with hazardous waste issues, responsible for preventing or reducing the harmful effects of exposure to hazardous substances on human health and quality of life. ATSDR is part of the U.S. Department of Health and Human Services.
Aquifer	An underground formation composed of materials such as sand, soil, or gravel that can store and/or supply groundwater to wells and springs.
Background Levels	Levels of chemicals that are present in the environment due to human-made sources, unrelated to a contaminated site.
Cancer Risk Evaluation Guide (CREG)	The concentration of a chemical in air, soil or water that is expected to cause no more than one excess cancer in a million persons exposed over a lifetime. The CREG is a <i>comparison value</i> used to select contaminants of potential health concern and is based on the <i>cancer slope factor</i> (CSF).
Cancer Slope Factor	A number assigned to a cancer causing chemical that is used to estimate it's ability to cause cancer in humans.
Carcinogen	Any substance that can cause or contribute to the production of cancer.
Comparison value	A concentration of a chemical in soil, air or water that, if exceeded, requires further evaluation as a contaminant of potential health concern. The terms comparison value and screening level are often used synonymously.
Contaminant	Any chemical that exists in the environment or living organisms that is not normally found there.

Dose	A dose is the amount of a substance that gets into the body through ingestion, skin absorption or inhalation. It is calculated per kilogram of body weight per day.
Environmental Media Evaluation Guide (EMEG)	A concentration in air, soil, or water below which adverse noncancer health effects are not expected to occur. The EMEG is a <i>comparison value</i> used to select contaminants of potential health concern and is based on ATSDR's <i>minimal risk level</i> (MRL).
Exposure	Contact with a chemical by swallowing, by breathing, or by direct contact (such as through the skin or eyes). Exposure may be short-term (acute) or long-term (chronic).
Groundwater	Water found underground that fills pores between materials such as sand, soil, or gravel. In aquifers, groundwater often occurs in quantities where it can be used for drinking water, irrigation, and other purposes.
Hazardous substance	Any material that poses a threat to public health and/or the environment. Typical hazardous substances are materials that are toxic, corrosive, ignitable, explosive, or chemically reactive.
Indeterminate public health hazard	Sites for which no conclusions about public health hazard can be made because data are lacking.
Lowest Observed Adverse Effect Level (LOAEL)	LOAELs have been classified into "less serious" or "serious" effects. In dose-response experiments, the lowest exposure level at which there are statistically or biologically significant increases in the frequency or severity of adverse effects between the exposed population and its appropriate control.
Media	Soil, water, air, plants, animals, or any other part of the environment that can contain contaminants.

Minimal Risk Level (MRL)	An amount of chemical that gets into the body (i.e., dose) below which health effects are not expected. MRLs are derived by ATSDR for acute, intermediate, and chronic duration exposures by the inhalation and oral routes.
Model Toxics Control Act (MTCA)	The hazardous waste cleanup law for Washington State.
Monitoring wells	Special wells drilled at locations on or off a hazardous waste site so water can be sampled at selected depths and studied to determine the movement of groundwater and the amount, distribution, and type of contaminant.
No apparent public health hazard	Sites where human exposure to contaminated media is occurring or has occurred in the past, but the exposure is below a level of health hazard.
Nonaqueous phase liquids	Nonaqueous phase liquids (NAPLs) are chemicals that are present in the subsurface as a liquid. These can be individual chemicals like trichloroethene (TCE), a solvent, or a mixture such as gasoline. Light NAPLs (i.e. LNAPLs) are liquids that float on the groundwater table and include chemicals like gasoline. Dense NAPLs (i.e. DNAPLs) are heavier than water and sink forming lenses or pockets of the chemical in a groundwater aquifer. Both LNAPLs and DNAPLs can also be found in the vadose zone as residue on soil particles or in pools or pockets on low permeability soil lenses.
No Observed Adverse Effect Level (NOAEL)	The dose of a chemical at which there were no statistically or biologically significant increases in frequency or severity of adverse effects seen between the exposed population and its appropriate control. Effects may be observed at this dose but were judged not to be "adverse."
No public health hazard	Sites for which data indicate no current or past exposure or no potential for exposure and therefore no health hazard.

Oral Reference Dose (RfD)	An amount of chemical ingested into the body (i.e., dose) below which health effects are not expected. RfDs are published by EPA.
Organic	Compounds composed of carbon, including materials such as solvents, oils, and pesticides which are not easily dissolved in water.
Parts per billion (ppb)/Parts per million (ppm)	Units commonly used to express low concentrations of contaminants. For example, 1 ounce of trichloroethylene (TCE) in 1 million ounces of water is 1 ppm. 1 ounce of TCE in 1 billion ounces of water is 1 ppb. If one drop of TCE is mixed in a competition size swimming pool, the water will contain about 1 ppb of TCE.
Plume	An area of contaminants in a specific media such as groundwater.
Remedial investigation	A study designed to collect the data necessary to determine the nature and extent of contamination at a site.
U.S. Environmental Protection Agency (EPA)	Established in 1970 to bring together parts of various government agencies involved with the control of pollution.
Vadose Zone	Soils located above the groundwater table.
Volatile organic compound (VOC)	An organic (carbon-containing) compound that evaporates (volatilizes) easily at room temperature. A significant number of the VOCs are commonly used as solvents.

Background and Statement of Issues

This health consultation summarizes the Washington State Department of Health's (DOH's) evaluation of indoor air studies conducted at homes and businesses located near the Philip Services Corporation (PSC) facility in the Georgetown neighborhood of Seattle, King County, Washington. The evaluation was conducted to determine whether residents and workers, who are located in the vicinity of the PSC site, are being exposed to hazardous chemicals released into soil and groundwater. Of primary concern is the potential for volatile organic compounds (VOCs) to move from contaminated groundwater into indoor air. The soil to indoor air pathway was also evaluated for those buildings located immediately west of the PSC facility, where elevated levels of soil contaminants have been detected or potentially exist. DOH conducts health consultations under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR).

The PSC facility is currently a temporary storage facility for industrial and household hazardous waste, located at 734 S. Lucile Street (Figure 1). The facility receives, packages, and ships hazardous waste for off-site treatment and/or disposal. In the past, some of the hazardous waste was treated at the facility. Leaking underground storage tanks and other past releases appear to be the source of contaminants detected in soil and groundwater at and downgradient of the facility. These contaminants include volatile organic compounds (VOCs) such as trichloroethylene (TCE), vinyl chloride, methylene chloride, and petroleum.¹

The underground tanks were reportedly removed in 1987 along with a limited amount of contaminated soil.^{2,3} A soil vapor extraction (SVE) system was installed at the facility as an interim measure in 1994 to reduce the concentration of VOCs remaining in soil near the former tanks. The SVE system continues to operate today.⁴ Its effectiveness, however, cannot be determined because soil sampling has not been conducted.

Although some VOCs have been removed by the SVE system, soils on the PSC property contain elevated VOC levels. VOCs have also been detected in soil on the commercial and industrial properties located between the PSC property and Denver Avenue South. All of these properties are also underlain by significant concentrations of groundwater contaminants. Groundwater concentrations at some of the monitoring wells located on these properties suggests that nonaqueous phase liquids (NAPLs) may also exist in the underlying aquifers. NAPLs also likely exist in vadose zone soils on the PSC property.^{1,5}

Groundwater contaminant plumes extend west from the facility to the Duwamish River and underlie a large residential, commercial, and industrial area between South Bennett Street to the north and South Fidalgo Street to the south.^{1,5,6} PSC has surveyed homes and businesses in the area and determined that the contaminated groundwater is not used for domestic purposes (drinking water or other household uses), industrial use, or irrigation. Water is supplied to homes and businesses by the City of Seattle.⁷ As a result, area residents and workers are not expected to be exposed to VOCs through ingestion or dermal contact. VOCs dissolved in shallow

groundwater, however, can volatilize and move up through the overlying soil column and potentially travel into indoor air where they can be inhaled.

From October 1999 to the March 2001, four environmental studies were conducted in the area immediately west of the PSC property to determine whether VOCs were migrating from the contaminated groundwater to indoor air. The purpose and locations of these studies are summarized below; detailed information about the studies is provided in Appendix A.

- **PSC, Soil Gas and Soil Study, October 1999**

The October 1999, PSC study was conducted to determine whether groundwater contaminants had volatilized into the overlying soil in the vicinity of three residences along the west side of Denver Avenue South (Residence 0, Residence 1, and Residence 3)(Figure 2). VOC concentrations in groundwater near these homes were among the highest detected anywhere west of Denver Avenue South. Soil samples were also collected to determine whether contaminated soil gas was affecting soils as the gas migrated toward the ground surface (Personal communication with Ed Jones, Ecology, October 24, 2002). Soil and soil gas samples were collected near the three homes to support the study.⁸

- **PSC Indoor Air Study, August 2000**

PSC conducted another study in August 2000 so it could evaluate whether VOCs found in groundwater were entering homes and if so, whether this was occurring at levels of health concern. Indoor air samples were collected at two of the three residences previously evaluated in October 1999 (Residence 1 and Residence 2) (Figure 2). PSC also collected groundwater, soil gas, and outdoor air samples during this study to help determine whether contaminants detected in indoor air were associated with contaminated groundwater or outdoor air.⁹

- **DOH/Environmental Protection Agency (EPA) Indoor Air Study, August 2000**

DOH and EPA conducted indoor air sampling approximately one week after PSC's August 2000, indoor air sampling. The DOH and EPA study was also conducted to evaluate whether VOCs found in groundwater were entering homes and if so, whether this was occurring at levels of health concern. DOH sampled the two homes previously tested by PSC (Residence 1 and Residence 2) along with Residence 3 (Figure 2). A sample was also collected by DOH at Business 1. EPA collected indoor air samples at Residence 2 and Business 2 and also collected an outdoor air sample near Residence 3.¹⁰

- **DOH Indoor Air Investigation and Concurrent PSC Soil Gas, Groundwater, and Ambient Air Study, March 2001**

Based on the findings from the August 2000 indoor air sampling, DOH recommended that additional indoor air sampling be conducted during the winter months to determine whether there were seasonal differences in indoor air quality associated with the contaminated groundwater.¹⁰ Two of the residences previously sampled in August 2000 were resampled in March 2001 (Residence 1 and Residence 2). One of the businesses sampled in August 2000 (Business 2) was also resampled in March 2001; the sample location at that business, however, was changed. Three new residential locations (Residence 4, Residence 5, and Residence 6) and one new business location (Business 3) were added to the March 2001 sampling round. While DOH conducted the indoor air sampling, PSC concurrently sampled groundwater and soil gas in the city right-of-way near the homes and businesses to determine whether there was a correlation with the indoor air results.¹¹

Discussion

Indoor air samples were collected from seven homes and three businesses located near the PSC facility between October 1999 through March 2001. These homes and businesses were selected for sampling because of their proximity to elevated levels of volatile organic compounds (VOCs) in shallow groundwater. The samples were analyzed for VOCs to help determine whether the VOCs detected in groundwater were migrating through soil into the indoor air. A description of each study along with DOH's findings is presented in Appendix A.

It should be noted that the data obtained from these indoor air studies only provide a few snapshots of a complex, dynamic indoor air environment that can be influenced by contaminant levels in soil, groundwater, outdoor air, and indoor air. How these potential sources contribute to indoor air contamination at homes and businesses near the PSC site depends on meteorological (e.g., temperature, barometric pressure, and rainfall); hydrogeological (i.e., vadose zone soil characteristics, groundwater levels); and building conditions (e.g., building materials, foundation type (i.e., basement, slab on grade construction, and crawlspace); heating and ventilation system operation; air exchange rates between indoor and outdoor air; and maintenance activities (e.g., use of cleaning products, paints, and solvents).

Whether the conditions observed at the sampled homes and businesses are representative of all the homes and businesses located over the groundwater contaminant plumes or whether the types and concentrations of contaminants will change significantly over time because of VOC degradation is unknown. Only limited information is available about the structural integrity of buildings located over the plumes and the underlying shallow subsurface soils conditions, which play a significant role in the migration of VOCs from contaminated soil or groundwater to indoor air. In addition, groundwater contaminant concentrations will likely change over time as the plumes migrate and the contaminants degrade. The rates and types of contaminant changes that will occur cannot be predicted. Consequently, the potential risks to indoor air at homes and

businesses overlying the plumes may also change. The indoor air sampling results, therefore, should be used with caution when evaluating long-term exposures to indoor air contaminants. Additional groundwater and indoor air monitoring is necessary to supplement this data.

The following section summarizes the data evaluation process used by DOH to identify chemicals of health concern and determine their potential sources.

Data Evaluation Summary

Indoor air VOC results obtained during the August 2000 through March 2001 sampling rounds were evaluated to identify chemicals of potential health concern (COPC) associated with the PSC facility (Appendix A, Tables A-1 to A-3). Some of the chemicals were detected in indoor air. However, a number of them were either not detected or only detected infrequently. Because many of these nondetected chemicals are potentially associated with releases from the PSC facility, one-half of the laboratory reporting limit or practical quantitation limit (PQL), was assigned to these results rather than a value of zero. The reporting limit or PQL is the lowest level at which a chemical can be accurately quantified. Using one half of the PQL is a conservative, but common approach for evaluating chemicals that may be present but not detected.¹²

The VOCs results were first compared to health comparison values, which are conservative screening values. It should be noted that contaminants that exceeded their respective comparison values do not signify that a public health threat exists but rather indicate that the chemical be further evaluated as a COPC. The health comparison values used for this health consultation are provided in Appendix A, Tables A-1 to A-3, and described in Appendix B.

VOCs are commonly found in outdoor and indoor air in urban and rural environments. Urban areas like Seattle, where significant automobile and industrial activity occurs, generally have higher outdoor air VOC levels than rural areas. Because outdoor air moves into buildings through windows, vents, and doors, some of the VOCs detected in indoor air may be associated with outdoor sources. To evaluate the outdoor air contribution, the COPCs were compared to the outdoor air sampling results obtained during the indoor air sampling events. Outdoor air sampling results are described in Appendix A and listed in Tables A-1 to A-3. It should be noted that although some of the outdoor air samples were collected within the boundaries of the groundwater contaminant plumes, it was assumed that the VOCs migrating from the contaminated groundwater would not significantly affect outdoor air quality since they would be quickly diluted when released from the soil. Outdoor air literature values were reviewed and compared to the outdoor air sample results obtained over the contaminated groundwater, which confirmed this assumption. COPCs with levels less than the respective outdoor air results, therefore, were assumed to be associated with some outdoor air source and eliminated as a COPC. Chemicals results that exceeded health comparison and outdoor air results are identified in Appendix A, Tables A-1 to A-3, as bolded, shaded values.

Site groundwater and soil gas data were also reviewed to assess whether chemicals that exceeded health comparison values and outdoor air levels were associated with contaminated groundwater.

If these chemicals were also found in groundwater or soil gas, they were retained as COPC (Table 1).

Table 1 - Chemicals of Potential Health Concern (COPC)

COPCs		Indoor Air Literature		
Contaminant	Maximum Indoor Air Concentration (ug/m3)	Value (ug/m3)	Statistical Parameter	Reference
1,1,2,2-tetrachlorethane ^a	1.61	0.1	Mean	14
1,1-dichloroethene	1.2	NA		NA
1,1,2-trichloroethane	2.2	0.38-1.8	Geometric Mean	15
1,2-dichloroethane	5.91	0.14	Geometric Mean	15
1,2-dichloropropane	1.02	0.01	Median	16
benzene	10.2	10	Median	14
carbon tetrachloride	1.0	2.5	Mean	14
cis-1,3-dichloropropene	0.77	NA		NA
chloroform	2.2	0.5	Median	14
ethylbenzene	5.2	4.8	Median	14
methylene chloride	330	6		17
tetrachloroethene	6.44	5	Median	14
trichloroethene	17.19	0.7	Median	14
vinyl chloride	0.74	NA		NA

NA - not available

Indoor air studies conducted in homes and businesses around the U.S. indicate that background VOC levels in indoor air (i.e., levels of chemicals that are present in the environment due to man-made sources, unrelated to a contaminated site) often exceed outdoor air.^{13,14} Building materials and the use of common cleaning products, paints, solvents, and other chemicals are the typical types of man-made sources associated with these elevated indoor VOC concentrations. To conservatively estimate the influence of man-made sources on indoor air quality at the sampled homes and businesses, the maximum concentration of each COPC was compared to its respective indoor air literature value (Table 1). The literature values were obtained from peer-reviewed studies, one of which was based on a large national indoor air database developed by EPA; indoor air values were also obtained from EPA's Urban Air Toxic Monitoring Program.^{14,15,16,17} Median, rather than average, values were selected from these studies, when available, to reduce the bias created by outliers. Only single indoor air literature values, rather than ranges, were generally available.

All the COPCs, except carbon tetrachloride, exceeded the indoor air literature values, which suggests that contaminated groundwater is contributing some level of the COPCs to indoor air. The maximum level of carbon tetrachloride was 2.5 times lower than its respective average indoor air literature value suggesting that although groundwater and soil gas contain some carbon tetrachloride, contaminated groundwater may not be the source of this chemical in indoor

air. However, it was detected above outdoor air levels at three homes and one business. Carbon tetrachloride was used in the past as a propellant for aerosol cans, degreasing agent, and refrigerant.¹⁸ Although its use has been phased out, it is possible that the levels of carbon tetrachloride detected slightly above outdoor air levels are associated with old appliances. Because there is some uncertainty about the potential sources of carbon tetrachloride, it was retained as COPC.

Benzene and tetrachloroethene just slightly exceeded their respective median indoor air literature values (i.e., by factors of 1.02 and 1.28, respectively). Like carbon tetrachloride, they were retained as COPC because there is some uncertainty about the sources of these chemicals. Benzene was detected above outdoor air levels at only two homes. Only one of these two homes slightly exceeded the median indoor air literature value. These two homes, like the other homes in the studies, are located in an area where low levels of benzene have been detected in groundwater.¹¹ However, both homes were occupied by cigarette smokers. Cigarette smoke is a source of benzene and is another possible cause of the elevated concentrations of benzene detected in indoor air at these two homes.¹⁹ Tetrachloroethene, a common solvent, was only detected at one business above outdoor air levels. Although the tetrachloroethene level at this business only slightly exceeded the median indoor air literature value, it was retained as a COPC because the indoor air sample was collected near a sump in the vicinity of the shallow tetrachloroethene groundwater contaminant plume.

It should be noted, that this final COPC list (Table 1) is only applicable to the data sets evaluated for this health consultation. Other COPCs may be identified during subsequent indoor air sampling. In addition, the COPC list developed by DOH may differ somewhat from the COPC list developed by Ecology for making cleanup decision under the Model Toxics Control Act (MTCA) because different factors (e.g., frequency of detection) may be used when selecting COPCs.

Health Evaluation

Indoor air samples were generally taken at the homes and businesses located over the portions of the groundwater plumes where the highest VOC concentrations had been detected. Most of the VOCs detected are not considered COPC. However, the presence of some VOCs in indoor air above health comparison values, outdoor air levels, and indoor air literature values suggests that VOC contaminated groundwater may be posing a potential health risk.

- Noncancer Health Effects Evaluation

To estimate the potential for noncancer health effects, concentrations detected in indoor air were compared to EPA inhalation reference concentrations (RfCs). RfCs are concentrations of a chemical in air below which adverse noncancer health effects are not expected based on continuous (i.e., 24-hour per day) exposure.²⁰ RfCs are set well below the actual toxic effect levels (i.e., lowest observed adverse effect level (LOAEL) or no observed adverse effect level (NOAEL) found in studies upon which they are based). This approach provides additional health

protection to account for the uncertainty involved in setting these “safe” levels of exposure. For chemicals with no available RfC, such as methylene chloride, a dose was calculated based on continuous exposure and compared to the oral reference dose (RfD). The RfD is based on oral exposure and its use for comparison with inhalation exposure adds additional uncertainty.

Maximum levels of COPCs detected in indoor air did not exceed any respective RfCs. Only the dose estimated from exposure to the maximum level of methylene chloride (330 ug/m³) exceeded its RfD (Table 2). The RfD for methylene chloride is based on liver toxicity in rats exposed to very high doses over an extended period of time. While the exposure dose is 3-times higher than the RfD, it is still approximately 2 times lower than the level of exposure that shows no adverse effects. It is also important to note that the comparisons made during this health consultation assume a continuous, 24-hour exposure to maximum detected concentrations, which likely overestimates actual exposure. Therefore, exposure to methylene chloride or any of the chemicals detected in indoor air is unlikely to result in any adverse noncancer health effects.

Table 2 - Estimated Noncancer Hazards

COPCs	Maximum Concentration (ug/m³)	RfC (mg/m³)	RfD (mg/kg-day)	Hazard Quotient
1,1,2,2-tetrachlorethane	1.61			
1,1-dichloroethene	1.2	2.0e-01		6.0e-03
1,1,2-trichloroethane	2.2		4.0e-03	3.0e-01
1,2-dichloroethane	5.91			
1,2-dichloropropane	1.02	4.0e-03		2.6e-01
benzene	10.2			
carbon tetrachloride	1.0		7.0e-04	7.9e-01
cis-1,3-dichloropropene	0.77	2.0e-02		3.9e-02
chloroform	2.2			
ethylbenzene	5.2		2.9e-01	9.9e-03
methylene chloride	330		6.0e-02	3.0e+00
tetrachloroethene	6.44		1.0e-02	3.6e-01
trichloroethene	17.19	4.0e-02		4.3e-01
vinyl chloride	0.74	1.0e-01		7.4e-03

- Cancer Risk Evaluation

To estimate the cancer risk associated with the contaminants detected above health screening values and indoor/outdoor air background values, concentrations were compared to EPA unit risk values. A unit risk value represents the estimated lifetime cancer risk estimated to result from continuous exposure to 1 ug/m³ of contaminant in air.²¹ For chemicals with no available unit risk value, such as trichloroethene, a dose was calculated based on a continuous exposure and compared to the slope factor. The slope factor provides an estimate of the cancer risk from lifetime exposure to a contaminant.²¹ The contaminants that contribute the most cancer risk are 1,2 dichloroethane, methylene chloride, and trichloroethene (Table 3). The estimates generated by this approach, however, are theoretical and are associated with much uncertainty. Actual cancer risks associated with low level exposure to these contaminants may be lower and could be zero.

Table 3 - Estimated Cancer Risks

COPCs	Maximum Concentration (ug/m³)	Inhalation Unit Risk (per ug/m³)	Slope Factor (mg/day/kg)⁻¹	Cancer Risk Max
1,1,2,2-tetrachlorethane	1.61	5.8e-05		9.3e-05
1,1-dichloroethene	1.2			
1,1,2-trichloroethane	2.2	1.6e-05		3.5e-05
1,2-dichloroethane	5.91	2.6e-05		1.5e-04
1,2-dichloropropane	1.02			
benzene	10.2	7.8e-06		8.0e-05
carbon tetrachloride	1.0	1.5e-05		1.5e-05
cis-1,3-dichloropropene	0.77	4.0e-06		3.1e-06
chloroform	2.2		1.0e-02	6.3e-06
ethylbenzene	5.2		3.9e-03	5.8e-06
methylene chloride	330	4.7e-07		1.6e-04
tetrachloroethene	6.44		2.0e-03	3.7e-06
trichloroethene	17.19		4.0e-01	2.0e-03
vinyl chloride	0.74	8.8e-06		6.5e-06

Comparison with Background Indoor Air

The presence of VOCs in urban indoor air has been well established. Therefore, it is important to consider the background risks associated with typical indoor air when evaluating whether indoor air VOCs levels near the PSC facility are contributing additional health risks.

The cancer risk levels and hazard quotients (i.e., ratio of the dose of a single chemical over a specified period of time to its reference dose) associated with the maximum concentrations of

each COPC, where a corresponding indoor air literature values was available, were summed to conservatively estimate the health risks associated with the indoor air COPCs (Appendix D, Table D-1). Cancer risks and hazard quotients were also calculated and summed for the available indoor air literature values (Appendix D, Table D-2). While there is some uncertainty associated with this approach, it does provide a method for estimating the overall COPC cancer and noncancer health risks relative to background indoor air.

As noted in Table 4, the cancer risk associated with exposure to the maximum concentration of the specified COPCs is approximately an order of magnitude greater than would be expected in typical indoor air while the noncancer health risk is about 2 times greater than typical indoor air. It is important to note that no building contained all of the highest concentrations during a sampling round. Consequently, the health risk associated with exposure to these chemicals is likely overestimated.

Table 4 - Estimated Risks Associated with Exposure to Indoor Air COPCs near the PSC Site vs Indoor Air Literature Values

	Indoor COPCs near PSC site*	Indoor Air Literature Values
Cancer Risk	3 in 1,000	3 in 10,000
Hazard Index	5	3

* Note: Only those COPC that had corresponding indoor air literature values were used to calculate a cancer risk and hazard index.

All the VOCs evaluated during this health consultation, including those tested but not exceeding health comparison or outdoor air values, contribute to the overall health risk. To further estimate the indoor air health risks, the maximum and average concentrations for each of these chemicals were summed for each sampling round. The results of this additional evaluation are summarized in Table 5.

Table 5 - Estimated Total Health Risk for August 2000 and March 2001 Indoor Air Sampling Rounds

	August 2000 ¹⁰		March 2001*	
	Max Conc	Average Conc	Max Conc	Average Conc
Cancer Risk	2 in 1,000	5 in 10,000	3 in 1,000	6 in 10,000
Hazard Index	7	2	5	2

*Appendix D, Table D-3

The estimated cancer risks associated with the maximum and average concentrations of these VOCs in indoor air near the PSC site are similar to upper bound estimates of cancer risk

associated with background exposure to volatile organic compounds, which have been estimated as high as 1 in 1,000.^{17,22} The estimated noncancer risks for the maximum contaminant concentrations slightly exceed those estimated for the indoor air COPCs, described above. However, the noncancer risks for the average contaminant concentrations are slightly less.

Additional Evaluation

The indoor air results obtained from the sampled buildings were also evaluated to assess whether there are possible seasonal differences in indoor air quality. Only Residence 1 and Residence 2, however, were sampled during different seasons (August and March). Although less than an order of magnitude difference exists between contaminants detected in the two sampling rounds at each building, the contaminants detected during the August sampling round were slightly higher than the March sampling results (Appendix A, Tables A-1 to A-3). These findings appear reasonable given that little precipitation occurs in the late summer months to occupy soil pore spaces and dilute groundwater VOC concentrations at the water table, which fluctuates very little at the PSC's site, thereby allowing more VOCs to migrate up through the soil column into indoor air. Existing sampling data, however, are not sufficient to clearly define seasonal effects on the groundwater to indoor air pathway.

It was recently discovered that petroleum compounds, particularly gasoline range compounds, were released to groundwater at the PSC facility. Medium to high levels of gasoline have been detected in shallow groundwater in the northern portion of the PSC site, east of Denver Avenue South. The boundaries of the gasoline plume has not been defined. However, the plume extends at least to the west side of Denver Avenue South.^{4,6,23,24} Like the other VOCs, these gasoline range compounds are contaminants of concern for the indoor air pathway and need to be evaluated during subsequent indoor air sampling. The boundaries of the petroleum plume will also need to be defined to ensure that appropriate buildings are tested.

Child Health Initiative

The PSC site is located in a residential area where children potentially could be exposed to site contaminants through the indoor air exposure pathway. Children can be uniquely vulnerable to the hazardous effects of environmental contaminants. Children breathe more air per pound of body weight than do adults resulting in higher levels of exposure to contaminants in air. For these reasons, child exposures were considered when assessing health risks posed by this site.

Exposure to detected indoor air contaminants were evaluated as described in the discussion section, above. The doses calculated for individual chemicals are not expected to result in adverse health effects for children, or adults, based on comparison with toxicity values. The assessment did find that chronic exposure to multiple chemicals over many years (for example, 30 years) does indicate a slight increased cancer risk.

Conclusions

Levels of volatile organic compounds (VOCs) found in indoor air near the PSC site pose *no immediate or short-term health concern*. Many of the detected chemicals are present below levels of potential health concern. Levels of some VOCs in indoor air are above those normally found in an indoor air environment and some of these chemicals were also found in groundwater and soil gas. Consequently, part of the estimated health risk associated with indoor air is likely related to VOCs migrating from contaminated groundwater or soil. Long-term exposure to those chemicals indicates only a slight increased risk for cancer and non-cancer health effects.

The site remains an *indeterminate health hazard* because it is not known whether the levels of VOCs detected at homes and businesses sampled in August 2000 and March 2001 are representative of all the homes and businesses located over the groundwater contaminant plumes. Several factors can affect sampling results including seasonal change, soil type and differences in building structure. In addition, the chemical composition of the plume is likely to change over time as contaminants migrate and degrade. Consequently, additional VOC monitoring (i.e., groundwater and indoor air) is needed to accurately assess long-term exposure related to the groundwater to indoor air pathway.

Additionally, a plume of dissolved gasoline with undefined boundaries is located in the northeastern portion of the PSC site and may be contributing additional VOCs to indoor air. However, no gasoline analysis has been conducted at the potentially affected homes. The potential exposure to gasoline needs to be further evaluated.

Recommendations/Action Plan

1. Further evaluation of the indoor air pathway should be conducted at those homes and businesses overlying the VOC contaminated groundwater plumes associated with the PSC facility. More sampling and/or modeling data is needed to adequately characterize and evaluate the groundwater to indoor air pathway.

Action

- PSC should continue evaluating the indoor air pathway using the modeling procedures described in its Revised Inhalation Pathways Interim Measures Work Plan, dated August 12, 2002, and any subsequent approved revisions to that plan. Indoor air at occupied buildings between Denver Avenue South and the PCS facility that are underlain by contaminated groundwater and soil, as well as a few buildings west of Denver Avenue, should be sampled periodically to confirm that the modeling accurately predicts indoor air concentrations.
2. Indoor air testing should be conducted at the most vulnerable buildings overlying the gasoline plume to evaluate whether gasoline is a significant indoor air contaminant at these buildings.

Action

PSC should conduct indoor air sampling above the gasoline plume concurrent with the next groundwater sampling round. Ambient air samples should also be collected and analyzed for gasoline compounds.

3. DOH should review future project plans and reports related to the indoor air pathway.

Action

PSC should provide appropriate plans and reports to DOH for review.

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Appendix A

Evaluation of Indoor Air Studies

Evaluation of Indoor Air Studies

Four environmental studies were conducted between October 1999 and March 2001 to evaluate whether contaminants found in shallow groundwater located west of the PSC facility were migrating into indoor air at homes and businesses above levels of health concern. Each study was evaluated to determine if the data was adequate for determining potential health effects and establishing a link between indoor air contaminants and the contaminated groundwater. The results of the evaluation for each study are presented below:

PSC, Soil Gas and Soil Study, October 1999

The October 1999, PSC study was conducted to determine whether groundwater contaminants had volatilized into the overlying soil in the vicinity of three residences along the west side of Denver Avenue South. VOC concentrations in groundwater near these homes were among the highest detected anywhere west of Denver Avenue South. Soil samples were also collected to determine whether contaminated soil gas was affecting soils as the gas migrated toward the ground surface (Personal communication with Ed Jones, Ecology, October 24, 2002). Two of the homes are underlain by basements (Residence 1 and Residence 2); the third home has an unknown foundation type (Residence 0). Soil and soil gas samples were collected from zero to four feet below ground surface (bgs) near the three homes to support the study (Figure 2).⁸

Shallow soils (zero to four feet below ground surface (bgs) were collected in the vicinity of the three homes and were analyzed for volatile organic compounds (VOCs) using EPA Method 8260, a standard VOC analytical method. No VOCs were detected in these soil samples except for methylene chloride, which was attributed to laboratory contamination.⁸

Soil gas samples were also collected by PSC during this study. The samples were collected over a 20-minute period from zero to four feet bgs along the city right-of-way, some distance from the homes and above the base of the basement using unsealed soil gas probes fitted with 6-liter (6L) Summa canisters prepared under negative pressure and equipped with flow restrictors.⁸ However, the unsealed soil gas probes, which would allow ambient air to migrate down along the probe, and shallow sampling above the bottom of the basement where contaminants tend to pool and concentrate, likely resulted in samples that underestimated soil gas concentrations.

PSC Indoor Air, Groundwater, and Soil Gas Study August 2000

PSC conducted another study in August 2000 so it could evaluate whether VOCs found in groundwater were entering homes and if so, whether this was occurring at levels of health concern. Indoor air samples were collected at two of the three residences: (Residence 1 and Residence 2) (Figure 2). PSC also collected groundwater, soil gas, and ambient air samples during this study to help determine whether contaminants detected in indoor air were associated with groundwater or some other source such as outdoor air, building materials and/or household products.⁹

To prepare for the indoor air sampling PSC asked residents to leave their homes. The homes were then screened using a photo ionization detector (PID) to identify potential indoor sources of VOCs, which were to be removed if the sources could potentially affect the indoor air sampling results. Only one item was reportedly removed from Residence 1. After the screening was completed, windows and doors were opened and approximately five volumes of air were evacuated from the basements, where samples were to be collected, by running a box fan to flush stagnant air from the homes. After the air was removed, the windows and doors were closed and the air was allowed to equilibrate for approximately 24-hours prior to sampling.⁹

Three samples were collected in the basement apartment at Residence 1 - two on top of the bed and one in a sitting area. One sample was collected on top of the bed located in the basement bedroom at Residence 2. The samples were collected over a 24-hour period at each home using 6L Summa canisters prepared under negative pressure and equipped with flow regulators. Residents returned to their homes at the end of the sampling, approximately 72 hours after sampling preparation began. The samples were analyzed using a modified version of EPA Method TO-14 in the selected ion mode (SIM) method to achieve lower detection limits for chemicals such as vinyl chloride that are a significant health concern.⁹

Sampling Protocol Evaluation

The selection of indoor air sample locations and sampling methods appears adequate for assessing indoor air quality at these homes. Only minor analytical differences were noted among the three samples collected in the basement apartment at Residence 1. It is uncertain whether PSC approach for evacuating indoor air and then allowing a 24-hour equilibration period prior to sampling significantly influenced the indoor air results. However, when the results are compared to the DOH sampling results obtained one week later, only relatively minor differences in contaminant concentrations are observed. Consequently, it appears that this approach did not negatively affect the results. Table A-1 provides the maximum indoor air contaminant concentration detected by PSC at Residence 1 and Residence 2. Chemicals reported as nondetects were assigned a value of one-half of the practical quantitation limit (PQL).

Two ambient air samples were collected during the study. One sample (Ambient 1) was a composite sample, which consisted of grab samples of the air coming into Residence 2 collected every 30 minutes for approximately two hours during the air evacuation conducted 24-hours prior to the indoor air sampling. The second ambient air sample (Ambient 2) was collected north

of the two homes in the city right-of-way along Denver Avenue S. using a 6-liter (6L) Summa canister prepared under negative pressure and equipped with a flow regulator. Ambient 2 was collected during the same 24-hour period as the indoor air samples and was used during the health consultation to represent background ambient air concentrations.⁹ The Ambient 2 results are included in Table A-1.⁶

Soil gas samples were collected at a number of locations during the study. All the soil gas samples were collected over a 24-hour period using 6L Summa canisters prepared under negative pressure and equipped with flow regulators. The soil gas samples were analyzed using a modified version of EPA Method TO-14 (SIM). Some passive soil gas samples were also collected and analyzed using EPA TO -1.⁹

A soil gas sample was collected during the same period as the indoor air sampling from a drive point installed 1 to 2 feet through the basement floor at Residence 2 to evaluate soil gas concentrations directly below the building. A single angled drive point was also installed below Residence 2. PSC also installed and sampled two angled drive points 0.5 to 2 feet below the basement at Residence 1. The angled drive points were sampled a few days after the indoor air sampling. To evaluate the differences between soil gas levels below the homes and those encountered in close proximity to the homes, PSC installed five drive points in the city right-of-way at approximately the same depth as the drive points installed below the basement floors. Only the drive point installed directly below the basement floor at Residence 2 had an external seal to prevent the migration of air along the outside of the drive point during sampling.⁹ Consequently, the contaminant levels in the soil gas may be underestimated.

Eleven groundwater samples were collected as part of this study to try to correlate the soil gas and indoor air sampling results with the chemicals found in groundwater. Three groundwater samples were collected from the drive points installed for the soil gas sampling below Residence 1, Residence 2, and along Denver Avenue South. These drive points were pushed until they encountered groundwater. Three additional drive points were installed into the shallow groundwater aquifer along Denver Avenue South. The wells were purged and sampled using a peristaltic pump and were analyzed for VOCs using EPA Method 8260. A peristaltic pump, however, can cause sample aeration and a resulting loss of VOCs if samples are not properly collected.⁹ It is assumed that the samples were collected properly. However, if sampling resulted in significant aeration, groundwater contaminant concentrations may be underestimated.

To establish a correlation between chemicals detected in groundwater and those detected in soil gas and indoor air, groundwater samples should be collected at the water table. The groundwater samples collected by PSC, however, were collected from one to two feet below the top of the water table.⁹ Since little rainfall occurs during the summer months that could dilute the groundwater at the water table, sampling a few feet below the top of the water table should not result in significantly different concentrations than would be found at the water table.

Data Evaluation

The indoor air sampling results from the August 2000 sampling round were initially compared to health comparison values to begin identifying chemicals of potential health concern (COPC). The health comparison values used during the health consultation are listed in Tables A-1; general information about the health comparison values are discussed in Appendix B.

COPC, however, do not necessarily represent a public health hazard but indicate the need for further evaluation. All the chemical results that exceeded health comparison values were then compared to the 24-hour ambient air sample results obtained by PSC (Table A-1), which are similar to outdoor air literature values. Chemicals exceeding health comparison values and the ambient air results were carried forward as COPCs and are shown as bolded, shaded values in Table A-1.

Ten of the 29 chemicals tested in indoor air exceeded conservative health comparison values and ambient air concentrations. Four of the ten chemicals (1,1 dichloroethene; 1,2-dichloroethane; chloroform; and vinyl chloride) were detected in both soil gas and groundwater samples collected by PSC during the August sampling, which suggests that contaminated groundwater may be a source of some of these indoor air contaminants. Methylene chloride, carbon tetrachloride, and ethylbenzene were only detected in soil gas; 1,1,2-trichloroethane was only detected in groundwater. The remaining chemicals (1,1,2,2-tetrachloroethane and 1,2-dichloropropane) were not detected in either groundwater or soil gas, which suggests a source other than contaminated groundwater exists for these chemicals.⁶ However, this conclusion could not be confirmed using the soil gas and groundwater data because of potential problems identified with the methods used to collect these samples.

Review of the historic groundwater data for the site (April 1999 - May 2000) presented in PSC draft human health risk assessment (HHRA) indicates that methylene chloride has been detected in over a quarter of the groundwater samples; 1,2-dichloropropane was detected in about a fifth of the groundwater samples; and ethylbenzene was detected in about half of the groundwater samples. Only one groundwater sample contained detectable levels of carbon tetrachloride and no 1,1,2,2-tetrachloroethane was detected in any groundwater sample. However, it appears that the detection limits for carbon tetrachloride and 1,1,2,2-tetrachloroethane were periodically elevated.⁵ As a result, contaminated groundwater could be a source of the carbon tetrachloride and 1,1,2,2-tetrachloroethane detected in indoor air.

The ten chemicals were retained as COPC and further evaluated. The discussion section of the health consultation summarizes this additional evaluation.

DOH/EPA Indoor Air Study, August 2000

Approximately one week after the PSC August 2000 sampling, DOH and EPA collected indoor air samples at the same two homes (Residence 1 and Residence 2) as well as at an additional home (Residence 3) and two businesses (Business 1 and Business 2) to evaluate whether VOCs found in groundwater were entering homes and if so, whether this was occurring at levels of health concern.¹⁰ No screening level monitoring (e.g., PID) was conducted prior the sampling to determine if indoor sources were producing VOCs that could affect indoor air quality at the selected homes and businesses. In addition, no indoor air was evacuated prior to sampling as was conducted by PSC a week earlier and residents and workers were allowed to conduct normal daily activities during the sampling event.

DOH sampled three homes and one business - Residence 1 (basement living room, canister on a table approximately 2 feet above the floor); Residence 2 (basement, canister placed on the floor); Residence 3 (basement, canister placed on the floor) and Business 1 (canister placed on the floor near a sump) (Figure 2). DOH used the same type of sampling equipment as PSC when collecting the indoor air samples- 6L Summa canisters prepared under negative pressure and equipped with flow regulators. All the samples were analyzed using EPA Method TO-15 in the standard scan mode.¹⁰

EPA used 6L cylindrical canisters that pumped air into the samplers at a metered rate. These type of canisters are used by Ecology to evaluate ambient air quality [Personal communication, Ed Jones, WA Department of Ecology, July 18, 2002]. Although these canisters are different than the ones used by DOH and Philip, it is unlikely that their use would have affected the sample quality. EPA collected indoor air samples at Business 2 (warehouse, canister placed 3 feet above the floor, near a floor drain) as well as sample on the first floor of Residence 2 (approximately 4 feet above the floor). EPA also collected an ambient sample from the backyard of Residence 3 (3 feet above the ground surface, approximately 30 feet from Maynard Avenue South and 20 feet south of the residence (Figure 2). The EPA samples were analyzed using EPA Method TO-14. However, typical quality assurance data were not available to evaluate the accuracy of the analytical results results.(Personal communication with Ed Jones, Ecology, June 18, 2002).

Sampling Protocol Evaluation

Although DOH did not evacuate air from the homes prior to the indoor air sampling as was conducted by PSC a week earlier, the results obtained by DOH are similar to the results obtained by PSC. The results obtained by EPA, however, were significantly higher for some chemicals than the results obtained by either DOH or PSC. Because of the uncertainty about data quality and the lack of split samples at the locations where DOH and PSC sampled, the EPA data were not used during this health consultation. The indoor air data results, however, are provided in Appendix C, Table C-1.

Data Evaluation

Table A-2 provides a summary of the indoor air data results obtained at the three homes and two businesses sampled by DOH. The ambient air results obtained by PSC the previous week were assumed to be similar to background concentrations during the DOH sampling and were used during the data evaluation. The four chemicals detected by PSC a week earlier in indoor air, soil gas, and groundwater (1,1 dichloroethene; 1,2-dichloroethane; chloroform; and vinyl chloride) along with methylene chloride, tetrachloroethene; and ethylbenzene; and toluene were detected above health comparison value and ambient air levels during the DOH sampling in at least one of the residences and businesses. These five chemicals were also detected in groundwater and soil gas.

Other chemicals were also detected in at least one building above health comparison values and ambient air values during the DOH study including 1,1,2-trichloroethane; 1,2-dichloropropane; cis 1,3-dichloropropene; trichloroethene; and 1,1,2,2-tetrachloroethane.

Trichloroethene was detected in groundwater and soil gas during PSC's August 2000 sampling round. Cis 1,3-dichloropropene and 1,1,2-trichloroethane were detected in groundwater but not soil gas samples. Carbon tetrachloride was detected in soil gas only. Neither 1,2-dichloropropane or 1,1,2,2-tetrachloroethane were detected in soil gas or groundwater during the PSC' August 2000 study. However, 1,2-dichloropropane was detected in a small percentage of the January 2000 groundwater samples. No 1,1,2,2-tetrachloroethane was detected in any groundwater samples collected by PSC in January 2000. However, the detection limits for 1,1,2,2-tetrachloroethane were occasionally elevated.⁵ As a result, contaminated groundwater could be a source of the 1,1,2,2-tetrachlorethane detected in indoor air.

All the chemicals that exceeded the health comparison values and ambient air were carried forward for evaluation, which is presented in the discussion section of the health consultation report.

DOH Indoor Air Investigation, March 2001 and Concurrent PSC Soil Gas, Groundwater, and Ambient Air Study

An additional round of indoor air sampling was conducted by DOH in March 2001 to evaluate seasonal difference in indoor air quality and evaluate indoor air quality at some new locations identified by EPA. Because it appeared that rainfall could reduce the concentration of contaminants in soil gas and consequently indoor air, the sampling was conducted during a short period of no rainfall. Two of the residences and one business previously sampled in August 2000 were resampled: Residence 1, which was vacant during this sampling round; Residence 2; and Business 2. Three new residential locations (Residence 4, Residence 5, and Residence 6) and one new business location (Business 3) were determined by EPA to be potentially vulnerable to the shallow groundwater contamination and were added to sampling program. The locations in each building where samples were collected is summarized in Table A-3 (Appendix A) All the samples were collected in the breathing zone. Consistent with the DOH's August 2000 study, no screening level indoor air monitoring was conducted prior to sampling and people were not asked to leave their homes or businesses or limit their normal daily activities.

As in the previous DOH study, 6L Summa canisters prepared under negative pressure and equipped with flow regulators were used to collect the indoor air samples, which were collected over a 24-hour period except the sample at Residence 2 where the canisters operated for approximately 32 hours because the resident was not home at the end of the scheduled sampling event. All the samples were analyzed using EPA Method TO-15 using the SIM mode to obtain lower practical quantitation limits (PQLs).

While DOH collected indoor air samples, PSC conducted concurrent groundwater and soil gas sampling in the city right-of-way near the homes and businesses in an attempt to again establish a correlation between indoor air and groundwater contaminant concentrations. Soil gas samples were collected over an approximately 30-minute interval from soil probes that were screened from 4 to 6 feet bgs using Summa canisters with dedicated flow regulators. The soil gas probes were sealed with bentonite at the ground surface to prevent migration of ambient air along the outside of the soil gas probe. As done previously, the soil gas samples were analyzed using a modified version of EPA Method TO-14 in the SIM mode. Thirty-minute ambient air samples were also collected by PSC during the study. Groundwater samples were obtained from permanent wells using submersible pumps and temporary wells using a peristaltic pump. Samples collected with the peristaltic pump were obtained after purging one gallon of groundwater then pulling the tubing and collecting the sample from the bottom of the tubing to minimize the loss of the VOCs. Groundwater samples were obtained from the permanent wells using dedicated submersible pumps that were run at low flows (i.e., less than 300 ml/min.). The groundwater water samples were analyzed using EPA Method 8260 limited to the chemicals analyzed for the soil gas sampling.¹³ Table A-3 summarizes the analytical results. Chemicals reported as nondetected were assigned a value of one-half of the PQL.

Data Evaluation

Consistent with the previous evaluations, the indoor air sampling results were initially compared to health comparison values to begin identifying chemicals of potential health concern. All the chemical results that exceeded health comparison values were then compared to ambient air in attempt to identify chemicals that were potentially elevated as a result of contaminated groundwater rather than an indoor or outdoor air source. Ambient air samples collected by Philip during this study were only collected for 30 minutes. Although the samples were collected for a very short time period, the concentrations obtained from the 30-minute samples are similar to literature values for ambient air and were used for this evaluation.

Those VOCs that exceeded ambient air and/or indoor air literature values and health comparison values at each residence are shown on Table A-3 as bolded, shaded values. These chemicals were also seen in the August sampling round and were carried forward as COPC.

Table A-1: PSC August 2000 Indoor Air Results and Screening Values

Contaminant	Screening Values (ug/m ³)			Indoor Air Results (ug/m ³)	
	Health Comparison Value	Ref.*	24-hour Outdoor Air Results	Residence 1 Basement	Residence 2 Basement
1,1,1-trichloroethane	2300	25	2.4	3.2	2.1
1,1,2,2-tetrachloroethane	0.1	26b	<i>0.10</i>	<i>0.10</i>	0.41
1,1,2-trichloroethane	0.06	26b	<i>0.08</i>	<i>0.08</i>	0.19
1,1-dichloroethane	510	25	<i>0.06</i>	<i>0.06</i>	<i>0.14</i>
1,1-dichloroethene	0.02	26b	<i>0.029</i>	0.06	0.14
1,2,4-trichlorobenzene	210	25	NA	NA	NA
1,2-dichloroethane	0.04	26b	0.18	0.2	4.1
1,2-dichlorobenzene	330	25	<i>0.09</i>	<i>0.09</i>	<i>0.21</i>
1,2-dichloropropane	0.092	25	<i>0.07</i>	<i>0.07</i>	0.16
1,3-butadiene	0.004	26b	NA	NA	NA
1,3-dichlorobenzene	3.3	25	<i>0.09</i>	<i>0.09</i>	<i>0.21</i>
1,4-dichlorobenzene	601	27	<i>0.09</i>	0.38	<i>0.21</i>
2-butanone	1000	25	NA	NA	NA
acetone	30,881	27	27	38	35
benzene	0.1	26b	5.4	3.9	1.6
bromoethane	19	27	NA	NA	NA
cis-1,2-dichloroethene	37	25	<i>0.06</i>	<i>0.06</i>	<i>0.14</i>
cis-1,3-dichloropropene	0.3	26b	<i>0.07</i>	<i>0.07</i>	<i>0.16</i>
carbon tetrachloride	0.07	26b	0.80	1	0.69
chlorobenzene	62	25	<i>0.07</i>	0.14	<i>0.16</i>
chloroform	0.04	26b	0.27	0.83	0.37
chloromethane	103	27	<i>0.03</i>	2	1.5
ethylbenzene	1.6	25	0.68	1.9	0.8
freon-11	730	25	NA	NA	NA
freon-113	31,000	27	<i>0.11</i>	0.70	2.8
freon-12	180	25	NA	NA	NA
m,p-xylene	434	27	2.1	5.8	2.2
methylene chloride	3	26b	1.7	130	330
o-xylene	434	27	<i>0.67</i>	1.7	0.7
tetrachloroethene	1.8	26b	2.7	2.6	1.4
styrene	256	27	0.20	0.62	0.41
trans-1,2-dichloroethene	793	26a	<i>0.06</i>	<i>0.06</i>	<i>0.14</i>
trichloroethene	0.009	26b	6.7	3.3	4.5
toluene	301	27	8.3	23	13
vinyl chloride	0.1	26b	<i>0.019</i>	0.15	<i>0.044</i>

Bolded and shaded values indicate the value exceeds health comparison value and outdoor air chemical concentration.

Italicized values represent one-half the detection limit for those contaminants that were below detection.

*25 - EPA Region III, RBCs; 26a- ATSDR EMEG; 26b-ATSDR CREG; 27-EPA Region IX RBCs

Table A-2: DOH August 2000 Indoor Air Study Results and Screening Values

Contaminant	Screening Values (ug/m ³)			Indoor Air Results (ug/m ³)			
	Health Comparison Value	Ref.*	24-hour Outdoor Air Results	Residence 1 Basement	Residence 2 Basement	Residence 3 Basement	Business 1 Near Sump
1,1,1-trichloroethane	2300	25	2.4	0.74	0.74	4.42	0.74
1,1,2,2-tetrachloroethane	0.1	26b	0.10	1.61	1.61	1.61	1.61
1,1,2-trichloroethane	0.06	26b	0.08	0.65	0.65	0.65	0.65
1,1-dichloroethane	510	25	0.06	0.67	0.67	0.67	0.67
1,1-dichloroethene	0.02	26b	0.029	1.03	1.03	1.03	1.03
1,2,4-trichlorobenzene	210	25	NA	5.56	5.56	5.56	5.56
1,2-dichloroethane	0.04	26b	0.18	1.42	5.91	1.42	0.74
1,2-dichlorobenzene	330	25	0.09	0.66	0.66	0.66	0.66
1,2-dichloropropane	0.092	25	0.07	1.02	1.02	1.02	1.02
1,3-butadiene	0.004	26b	NA	NA	NA	NA	NA
1,3-dichlorobenzene	3.3	25	0.09	0.60	0.60	0.60	0.60
1,4-dichlorobenzene	601	27	0.09	0.87	0.87	0.87	0.87
2-butanone	1000	25	NA	1.77	22.41	9.73	5.90
acetone	30,881	27	27	28.49	23.27	28.49	26.12
benzene	0.1	26b	5.4	0.65	0.65	0.65	1.50
bromomethane	19	27	NA	1.18	1.18	1.18	1.18
cis-1,2-dichloroethene	37	25	0.06	0.57	0.57	0.57	0.57
cis-1,3-dichloropropene	0.3	26b	0.07	0.77	0.77	0.77	0.77
carbon tetrachloride	0.07	26b	0.80	0.56	0.56	0.56	0.56
chlorobenzene	62	25	0.07	0.90	0.90	0.90	0.90
chloroform	0.04	26b	0.27	2.20	0.85	0.85	0.85
chloromethane	103	27	0.03	1.57	0.64	1.88	1.80
ethylbenzene	1.6	25	0.68	1.35	1.35	1.35	8.25
freon-11	730	25	NA	1.91	10.11	5.62	2.02
freon-113	31,000	27	0.11	0.61	0.61	0.61	2.30
freon-12	180	25	NA	2.92	3.36	11.86	3.26
m,p-xylene	434	27	2.1	5.21	1.74	3.99	27.78
methylene chloride	3	26b	1.7	93.75	180.55	18.75	4.17
o-xylene	434	27	0.67	1.32	1.32	1.32	6.08
tetrachloroethene	1.8	26b	2.7	1.32	1.49	1.49	6.44
styrene	256	27	0.20	1.23	0.57	0.57	0.57
trans-1,2-dichloroethene	793	26a	0.06	1.27	1.27	1.27	1.27
trichloroethene	0.009	26b	6.7	1.42	1.42	17.19	1.42
toluene	301	27	8.3	9.42	21.10	22.98	33.90
vinyl chloride	0.1	26b	0.019	0.74	0.74	0.74	0.74

Bolded and shaded values indicate the value exceeds health comparison value and outdoor air chemical concentration.

Italicized values represent one-half the detection limit for those contaminants that were below detection.

*25 - EPA Region III, RBCs; 26a- ATSDR EMEG; 26b-ATSDR CREG; 27-EPA Region IX RBCs

Table A-3: DOH March 2001 Indoor Air Study Results and Screening Values

Contaminant	Screening Values (ug/m ³)				Indoor Air Results (ug/m ³)					
	Health Comparison Value	Ref.*	30-Minute Outdoor Air Results SG-9	30-Minute Outdoor Air Results SG-13	Residence 1 Basement	Resident 1 Basement	Residence 2 Basement	Residence 2 1 st Floor	Residence 4 Crawl Space	Residence 4 1 st Floor
1,1,1-trichloroethane	2300	25	0.39	0.25	3.8	4.1	2.2	3.0	0.4	0.3
1,1,2,2-tetrachloroethane	0.1	26b	0.12	0.11	0.3	0.2	0.2	0.2	0.2	0.2
1,1,2-trichloroethane	0.06	26b	0.10	0.08	0.3	0.1	2.2	0.1	0.1	0.1
1,1-dichloroethane	510	25	0.07	0.06	0.3	0.4	0.1	0.1	0.1	0.1
1,1-dichloroethene	0.02	26b	0.034	0.03	0.2	0.1	0.1	0.1	0.1	0.1
1,2,4-trichlorobenzene	210	25	NA	NA	0.4	0.2	0.2	0.2	0.2	0.2
1,2-dichloroethane	0.04	26b	0.07	0.06	0.2	0.1	0.8	0.3	0.1	0.1
1,2-dichlorobenzene	330	25	0.10	0.09	0.3	0.2	0.2	0.2	0.2	0.2
1,2-dichloropropane	0.092	25	0.8	0.07	0.2	0.1	0.1	0.1	0.1	0.1
1,3-butadiene	0.004	26b	NA	NA	NA	NA	NA	NA	NA	NA
1,3-dichlorobenzene	3.3	25	0.10	0.09	0.3	0.2	0.2	0.2	0.2	0.2
1,4-dichlorobenzene	601	27	0.10	0.09	0.3	0.2	0.2	0.2	0.5	12
2-butanone	1000	25	NA	NA	3.8	1.6	5.0	3.2	2.3	4.1
acetone	30,881	27	4.8	3.2	35.6	8.5	49.9J	49.9J	10.0	61.7
benzene	0.1	26b	3.1	2.2	1.9	1.8	1.4	1.4	2.3	3.8
bromomethane	19	27	NA	NA	0.2	0.1	0.1	0.1	0.1	0.1
cis-1,2-dichloroethene	37	25	0.07	0.06	0.2	0.1	0.1	0.1	0.1	0.1
cis-1,3-dichloropropene	0.3	26b	0.08	0.07	0.2	0.1	0.1	0.1	0.1	0.1
carbon tetrachloride	0.07	26b	0.54	0.56	0.6	0.6	0.5	0.5	0.5	0.5
chlorobenzene	62	25	0.08	0.07	0.2	0.1	0.1	0.1	0.1	0.1
chloroform	0.04	26b	0.09	0.08	0.3	0.3	0.1	0.1	0.1	0.7
chloromethane	103	27	1.2	1.1	1.3	1.0	0.9	0.9	0.9	3.1
ethylbenzene	1.6	25	1.3	0.12	1.2	1.2	0.8	0.9	1.4	2.1
freon-11	730	25	NA	NA	2.1	2.0	13.5	2.2	1.5	1.8
freon-113	31,000	27	0.13	0.12	1.0	1.0	2.0	0.6	0.6	0.6
freon-12	180	25	3.5	1	28.7	33.6	2.8	6.4	2.4	2.2
m,p-xylene	434	27	5.1	3.8	4.3	3.6	2.5	2.7	4.8	6.5
methylene chloride	3	26b	0.78	43	1.8	1.7	2.4	38.2	38.2	8.0
o-xylene	434	27	2	1.5	1.6	1.6	1.2	1.0	2.1	2.5
tetrachloroethene	1.8	26b	0.33	0.26	0.5	0.5	0.4	2.0	0.2	0.2

Contaminant	Screening Values (ug/m ³)				Indoor Air Results (ug/m ³)					
	Health Comparison Value	Ref.*	30-Minute Outdoor Air Results SG-9	30-Minute Outdoor Air Results SG-13	Residence 1 Basement	Resident 1 Basement	Residence 2 Basement	Residence 2 1 st Floor	Residence 4 Crawl Space	Residence 4 1 st Floor
styrene	256	27	0.38	0.17	0.8	0.5	0.3	0.5	0.3	1.7
trans-1,2-dichloroethene	793	26a	<i>0.34</i>	<i>0.30</i>	<i>0.2</i>	<i>0.1</i>	<i>0.1</i>	<i>0.1</i>	<i>0.1</i>	<i>0.1</i>
trichloroethene	0.009	26b	0.09	0.08	0.3	0.3	0.3	2.8	0.4	0.3
toluene	301	27	7.3	5.6	11.7	7.5	5.3	8.7	7.9	24.1
vinyl chloride	0.1	26b	0.022	0.020	<i>0.1</i>	<i>0.1</i>	<i>0.1</i>	<i>0.1</i>	<i>0.1</i>	<i>0.1</i>

Bolded and shaded values indicate the value exceeds health comparison value and outdoor air chemical concentration.

Italicized values represent one-half the detection limit for those contaminants that were below detection.

*25 - EPA Region III, RBCs; 26a- ATSDR EMEG; 26b-ATSDR CREG; 27-EPA Region IX RBCs

Table A-3: DOH March 2001 Indoor Air Study Results and Screening Values

Contaminant	Screening Values (ug/m ³)				Indoor Air Results (ug/m ³)			
	Health Comparison Value	Ref.*	30-Minute Outdoor Air Results SG-9	30-Minute Outdoor Air Results SG-13	Residence 5 1 st Floor	Residence 6 Basement	Business 2 Office	Business 3 Basement
1,1,1-trichloroethane	2300	25	0.39	0.25	0.4	0.7	120.0	0.7
1,1,2,2-tetrachloroethane	0.1	26b	0.12	0.11	0.2	0.2	0.2	0.2
1,1,2-trichloroethane	0.06	26b	0.10	0.08	0.1	0.1	0.1	0.1
1,1-dichloroethane	510	25	0.07	0.06	0.1	0.1	19.4	0.1
1,1-dichloroethene	0.02	26b	0.034	0.03	0.1	0.1	1.2	0.1
1,2,4-trichlorobenzene	210	25	NA	NA	0.2	0.2	0.2	0.2
1,2-dichloroethane	0.04	26b	0.07	0.06	0.1	0.2	0.4	0.1
1,2-dichlorobenzene	330	25	0.10	0.09	0.2	0.2	1.6	0.2
1,2-dichloropropane	0.092	25	0.8	0.07	0.1	0.1	0.1	0.1
1,3-butadiene	0.004	26b	NA	NA	NA	NA	NA	NA
1,3-dichlorobenzene	3.3	25	0.10	0.09	0.2	0.2	0.2	0.2
1,4-dichlorobenzene	601	27	0.10	0.09	0.8	0.4	204.3	2.6
2-butanone	1000	25	NA	NA	7.7	3.8	2.7	2.9
acetone	30,881	27	4.8	3.2	498.6	52.2	45.1	47.5J
benzene	0.1	26b	3.1	2.2	10.2	6.1	1.5	1.8
bromomethane	19	27	NA	NA	0.1	0.1	0.1	0.1
cis-1,2-dichloroethene	37	25	0.07	0.06	0.1	0.1	16.6	0.1
cis-1,3-dichloropropene	0.3	26b	0.08	0.07	0.1	0.1	0.1	0.1
carbon tetrachloride	0.07	26b	0.54	0.56	0.8	0.6	0.6	0.5
chlorobenzene	62	25	0.08	0.07	0.1	0.1	0.1	0.1
chloroform	0.04	26b	0.09	0.08	1.7	0.1	0.8	0.7
chloromethane	103	27	1.2	1.1	9.3	1.0	0.9	0.9
ethylbenzene	1.6	25	1.3	0.12	3.4	3.5	5.2	1.0
freon-11	730	25	NA	NA	1.9	46.1	2.5	1.6
freon-113	31,000	27	0.13	0.12	0.6	0.6	71.2	0.7
freon-12	180	25	3.5	1	2.6	8.4	2.4	2.6
m,p-xylene	434	27	5.1	3.8	10.4	12.6	17.4	3.3
methylene chloride	3	26b	0.78	43	3.3	1.7	3.8	2.4
tetrachloroethene	1.8	26b	0.33	0.26	0.8	0.5	1.4	0.4

Contaminant	Screening Values (ug/m ³)				Indoor Air Results (ug/m ³)			
	Health Comparison Value	Ref.*	30-Minute Outdoor Air Results SG-9	30-Minute Outdoor Air Results SG-13	Residence 5 1 st Floor	Residence 6 Basement	Business 2 Office	Business 3 Basement
styrene	256	27	0.38	0.17	4.7	3.8	1.1	0.5
trans-1,2-dichloroethene	793	26a	<i>0.34</i>	<i>0.30</i>	<i>0.1</i>	<i>0.1</i>	0.5	<i>0.1</i>
trichloroethene	0.009	26b	0.09	0.08	6.4	1.2	12.9	9.1
toluene	301	27	7.3	5.6	33.9	20.3	9.4	6.0
vinyl chloride	0.1	26b	0.022	0.020	<i>0.1</i>	<i>0.1</i>	<i>0.1</i>	<i>0.1</i>

Bolded and shaded values indicate the value exceeds health comparison value and outdoor air chemical concentration.
Italicized values represent one-half the detection limit for those contaminants that were below detection.

*25 - EPA Region III, RBCs; 26a- ATSDR EMEG; 26b-ATSDR CREG; 27-EPA Region IX RBCs

Appendix B

Health Comparison Values

Health Comparison Values

Media-specific health comparison values are contaminant concentrations in specific media (i.e., soil, water and air) used to select contaminants of concern for further evaluation. If the concentration of a chemical exceeds a health comparison value, it does not mean that a public health threat exists but rather signifies that the chemical be further evaluated.

The health comparison values used in this public health assessment include environmental media evaluation guidelines (EMEGs) and cancer risk evaluation guidelines (CREGs). EPA Region IX and Region III risk based concentrations were also used when no other comparison values were available.

EMEGs are media-specific health comparison values derived from minimal risk levels (MRLs) presented in ATSDR Toxicological Profiles. MRLs are estimates of daily exposure of a human to a chemical that is likely to be without an appreciable noncancer risk over a specified duration of exposure. CREGs are estimated media specific contaminant concentrations that are anticipated to result in one excess cancer risk in one million persons exposed over a lifetime. CREGs are derived from EPA's cancer slope factors (CSFs), also known as cancer potency factors. CSFs are cancer potency estimates derived for chemicals shown to be carcinogenic in animals or humans.

EPA Region IX and Region III conservative risk based screening concentrations are derived for carcinogenic and noncarcinogenic compounds using CSFs and RfDs, respectively. RfDs are estimates of daily exposure of a human to a chemical that is likely to be without an appreciable noncancer risk over a specified duration of exposure.

Appendix C

EPA August 2000 Indoor Air Sampling Results

Table C-1: EPA August 2000 Indoor Air Sampling Results

Contaminant	Residence 2 1st Floor	Business 2 Warehouse
1,1,1-trichloroethane	NA	NA
1,1,2,2-tetrachloroethane	0.14	0.07
1,1,2-trichloroethane	0.49	0.05
1,1-dichloroethane	59.96	45.12
1,1-dichloroethene	0.71	0.87
1,2,4-trichlorobenzene	0.22	0.15
1,2-dichloroethane	0.81	0.69
1,2-dichlorobenzene	0.12	0.06
1,2-dichloropropane	6.47	1.34
1,3-butadiene	0.42	0.11
1,3-dichlorobenzene	0.12	0.06
1,4-dichlorobenzene	16.71	35.70
2-butanone	NA	NA
acetone	NA	NA
benzene	29.95	6.39
bromomethane	3.79	3.48
cis-1,2-dichloroethene	10.82	16.49
cis-1,3-dichloropropene	0.54	0.27
carbon tetrachloride	0.69	1.70
chlorobenzene	37.09	8.97
chloroform	3.32	0.98
chloromethane	NA	NA
ethylbenzene	2.55	7.79
freon-11	15.16	11.16
freon-113	7.58	56.28
freon-12	13.30	3.84
m,p-xylene	20.97	30.73
methylene chloride	2.99	0.28
o-xylene	3.30	9.80
tetrachloroethene	25.22	10.17
styrene	NA	2.84
trans-1,2-dichloroethene	NA	NA
trichloroethene	3.06	12.52
toluene	349.98	23.81
vinyl chloride	1.05	NA

Appendix D

Risk Calculations

Table D-1: Cancer Risk and Noncancer Hazards - COPCs

Contaminant	Maximum Conc (ug/m³)	Inhalation Unit Risk (per ug/m³)	Slope Factor (mg/day/kg)⁻¹	RfC (mg/m³)	RfD (mg/kg-day)	Cancer Risk Max	Hazard Quotient Max
1,1,2,2-tetrachlorethane	1.61	5.8e-05				9.3e-05	
1,1-dichloroethene	1.2			2.0e-01			6.0e-03
1,1,2-trichloroethane	2.2	1.6e-05			4.0e-03	3.5e-05	3.0e-01
1,2-dichloroethane	5.91	2.6e-05				1.5e-04	
1,2-dichloropropane	1.02			4.0e-03			2.6e-01
benzene	10.2	7.8e-06				8.0e-05	
carbon tetrachloride	1.0	1.5e-05			7.0e-04	1.5e-05	7.9e-01
cis-1,3-dichloropropene	0.77	4.0e-06		2.0e-02		3.1e-06	3.9e-02
chloroform	2.2		1.0e-02			6.3e-06	
ethylbenzene	5.2		3.9e-03		2.9e-01	5.8e-06	9.9e-03
methylene chloride	330	4.7e-07			6.0e-02	1.6e-04	3.0e+00
tetrachloroethene	6.44		2.0e-03		1.0e-02	3.7e-06	3.6e-01
trichloroethene	17.19		4.0e-01	4.0e-02		2.0e-03	4.3e-01
vinyl chloride	0.74	8.8e-06		1.0e-01		6.5e-06	7.4e-03
Total Risk for Chemicals with Indoor Air Literature Values				Cancer Risk		2.5e-03	
				Hazard Index			5.2e+00

Table D-2: Cancer Risk and Noncancer Hazards - Indoor Air Literature Values

Contaminant	Maximum Conc (ug/m³)	Inhalation Unit Risk (per ug/m³)	Slope Factor (mg/day~kg)⁻¹	RfC (mg/m³)	RfD (mg/kg~day)	Cancer Risk Max	Hazard Quotient Max
1,1,2,2-tetrachlorethane	0.1	5.8e-05				5.8e-06	
1,1-dichloroethene				2.0e-01			
1,1,2-trichloroethane	1.8	1.6e-05			4.0e-03	2.9e-05	2.5e-01
1,2-dichloroethane	0.14	2.6e-05				3.6e-06	
1,2-dichloropropane	0.01			4.0e-03			2.5e-03
benzene	10	7.8e-06				7.8e-05	
carbon tetrachloride	2.5	1.5e-05			7.0e-04	3.8e-05	2.0e+00
cis-1,3-dichloropropene		4.0e-06		2.0e-02			
chloroform	0.5		1.0e-02			1.4e-06	
ethylbenzene	4.8		3.9e-03		2.9e-01	5.3e-06	9.2e-03
methylene chloride	6	4.7e-07			6.0e-02	2.8e-06	5.5e-02
tetrachloroethene	5		2.0e-03		1.0e-02	2.9e-06	2.8e-01
trichloroethene	0.7		4.0e-01	4.0e-02		8.0e-05	1.8e-02
vinyl chloride		8.8e-06		1.0e-01			
Total Risk for Chemicals with Indoor Air Literature Values				Cancer Risk		2.5e-04	
				Hazard Index			2.6e+00

Table D-3: Cancer and Noncancer Risks for March 2001 Maximum and Average Concentrations

Chemical	IUR				Indoor Air					
	(per	Slope Factor	Rfc	RfD	Max Conc.	Cancer		Avg Conc	Cancer	
	ug/m3)	(mg/kg/day) ⁻¹	mg/m3)	(mg/kg/day)	(ug/m3)	Risk	HQ	(ug/m3)	Risk	HQ
1,1,1-trichloroethane					120			13.6		
1,1,2,2-tetrachloroethane	5.8E-05				0.3	1.7E-05		0.2	1.2E-05	
1,1,2-trichloroethane	1.6E-05			4.0E-03	2.2	3.5E-05	3.0E-01	0.4	6.4E-06	5.5E-02
1,1-dichloroethane	1.6E-06		1.0E-01		23.1	3.7E-05	2.3E-01	2.5	4.0E-06	2.5E-02
1,1-dichloroethene			2.0E-01		1.2		6.0E-03	0.2		1.0E-03
1,2,4-trichlorobenzene				1.0E-02	0.4		2.2E-02	0.2		1.1E-02
1,2-dichloroethane	2.6E-05				0.8	2.1E-05		0.2	5.2E-06	
1,2-dichlorobenzene				9.0E-02	1.6		9.8E-03	0.3		1.8E-03
1,2-dichloropropane			4.0E-03		0.2		5.0E-02	0.1		2.5E-02
1,3-butadiene			2.0E-03		NA			NA		
1,3-dichlorobenzene					0.3			0.2		
1,4-dichlorobenzene	1.10E-05		8.0E-01		144.2	1.6E-03	1.8E-01	15.9	1.7E-04	2.0E-02
2-butanone			1.0E+00		13		1.3E-02	5.7		5.7E-03
acetone				1.0E-01	498.6		2.8E+00	88.7		4.9E-01
benzene	7.8E-06				9.6	7.5E-05		3.2	2.5E-05	
bromomethane			5.0E-03		0.2		4.0E-02	0.1		2.0E-02
cis-1,2-dichloroethene					16.6			1.8		
cis-1,3-dichloropropene	4.0E-06		2.0E-02		0.2	8.0E-07	1.0E-02	0.1	4.0E-07	5.0E-03
carbon tetrachloride	1.5E-05			7.0E-04	0.8	1.2E-05	6.3E-01	0.6	9.0E-06	4.7E-01
chlorobenzene				2.0E-02	0.2		5.5E-03	0.1		2.8E-03
chloroform		1.0E-02			1.7	4.9E-06		0.5	1.4E-06	
chloromethane					11.6			2.3		
ethylbenzene		3.9E-03		2.9E-01	6.1	6.8E-06	1.2E-02	2.2	2.5E-06	4.2E-03
freon-11				3.0E-01	46.1		8.5E-02	11.5		2.1E-02
freon-113					71.2			7.9		
freon-12				2.0E-01	33.6		9.3E-02	9.8		2.7E-02
m,p-xylene				2.0E+00	17.4		4.8E-03	6.9		1.9E-03
methylene chloride	4.7E-07			6.0E-02	38.2	1.8E-05	3.5E-01	10.5	4.9E-06	9.7E-02
o-xylene				2.0E+00	5.6		1.5E-03	2.6		7.2E-04
tetrachloroethene		2.0E-03		1.0E-02	2	1.1E-06	1.1E-01	0.7	4.0E-07	3.9E-02
styrene			1.0E+00		4.7		4.7E-03	1.4		1.4E-03
trans-1,2-dichloroethene				2.0E-02	0.5		1.4E-02	0.1		2.8E-03
trichloroethene		4.0E-01	4.0E-02		11.3	1.3E-03	2.8E-01	3.3	3.8E-04	8.3E-02
toluene			4.0E-01		33.9		8.5E-02	13.8		3.5E-02
vinyl chloride	8.8E-06		1.0E-01		0.1	8.8E-07	1.0E-03	0.1	8.8E-07	1.0E-03
					Total Risk-Max Conc			Total Risk-Avg Conc		
					Cancer	3.1E-03		Cancer	6.2E-04	
					HQ		5.3E+00	HQ		1.5E+00

Certification

This Health Consultation was prepared by the Washington State Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was begun.

Debra Gable
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ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health consultation and concurs with the findings.

Roberta Erlwein
Chief, SPS, SSAB, DHAC
ATSDR

